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Environmental Science

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Intermediate and Senior Divisions
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Introduction

This guideline marks out a domain for exploration by students and teachers of the Intermediate and Senior Divisions. It identifies four aspects of Environmental Science, suggests topics for each, and lists activities.

These activities are intended to provide specific starting points from which students can pursue more detailed investigations on topics that arouse their interest. At first glance, the activities and the varied paths of study that lead from them might appear unrelated and even haphazard; in due course, however, they will be seen as coherent aspects of a steadily growing conception of the environment. It is hoped that from the total concept the student will derive not only knowledge of his environment, but sensitivity to the relationships within it and a feeling of responsibility for the whole: in short, harmony with his surroundings.

Careful reading will show that most activities can be pursued on a level suitable for either the Intermediate or Senior Division. While Senior Division students might investigate an activity at greater depth than their younger colleagues, it is assumed that the same pattern would prevail for both groups: namely, exploration of individual and apparently disparate activities that join together like the pieces of a mosaic to form a total and valid concept of the environment.

This guideline is intended to replace *Science (Environmental) I-21, 1967/68.* In addition, Agriculture courses may be developed from topics within this guideline or may be based on Agriculture RP 21/1962 as at present.

The term *interim* in the title of this document indicates that the program for both divisions is under review or will be in the near future. In such a process, the opinions of teachers in the classrooms of the province are a necessary component. It is hoped, therefore, that the teachers using this guideline to plan a course will share the results of their experiences with those conducting the Intermediate and Senior Division reviews. Such comments, which may relate to planning a course or to work in the classroom, may be sent to the Regional Director of the Ministry of Education.

The way Environmental Science is introduced in a school or a family of schools will depend on the general plan for education that is being followed. In some, it may be offered as a continuum throughout all or part of the two divisions. In others, it may be a semester course. Some secondary schools may develop courses on a one-year basis, in either division, or on a two-year basis, spanning the two divisions. Where Environmental Science is not introduced as a separate course, it is possible to incorporate individual themes into existing courses. In addition, it would be possible to develop a complete course from a single topic within this guideline.

Rationale

The domain of environmental science includes the atmosphere, the land covered by farm and forest, and the lakes and streams with their plant life and animal inhabitants. These, of course, are not separate entities but parts of a single ecological network. The environment also includes man and his creations, that is, such transformations of the landscape as man-made cities and highways. Thus the domain becomes the world within reach of the student's inquiries, a world that affects his life and is affected by him.

Four aims could be set down for Environmental Science. As with other parts of the curriculum, the first aim of learning experiences devised from this guideline is to enhance the development of the student in his many dimensions. The second aim of Environmental Science is to help the student find logical patterns in terms of which he can understand and describe his environment. The third aim is to give students practice in various methods of investigation as well as experience with equipment and techniques currently used in specialized fields. The fourth aim is to encourage the student to become sensitive to environmental concerns and value issues within the community. This aim is central to the course because the quality of human life during the next century, and perhaps human survival, are dependent on an understanding of our environment and a common will to make decisions for the common good. All four aims imply a personal harmony with nature.

Teachers and students using *Environmental Science* to achieve these aims will rely on two major sources of information as a base for studies. First-order information is gathered directly from the environment. At times, the immediate neighbourhood of the school will provide data. At other times, students will need access to less modified areas farther away, and longer class periods will have to be made available to them. For second-order information, students will need to draw on the experiences of others through the learning materials of a well-stocked resource centre. For example, writers from the days of Vergil have described farm life; painters have depicted the landscape. Modern newspapers, periodicals, and books contain relevant information, much of it conflicting and thus particularly appropriate for students' individual judgements

Towards Course Development

and assessments. All this wealth of ideas and information can be used to support the direct study of the environment.

Environmental Science meshes with many other subjects: topics are related to topics in other subjects; units overlap with other units and almost any study of the environment requires data from such disciplines as agriculture, biology, chemistry, mathematics, technology, geography, geology, history, limnology, physics, and sociology. Fruitless repetition can be prevented by continuing consultation between the teacher and his colleagues and by careful planning with the student. Although it is superfluous to duplicate a complete learning experience, some overlap is desirable; education is a process in which concepts partially developed are expanded with each new experience. The development of individual concepts contributes to the totality of learning just as single pieces of tile combine to form the pattern of a mosaic. Topics link with topics and each new activity adds meaning to previous activities. Gradually, a student puts together these innumerable individual ideas to form a mosaic that is his own synthesis of the environment.

To encourage a student to form this unique mosaic of concepts and to depict the world in patterns that appear coherent in the light of his own experience, a wide range of activities is set down for each topic. Activities are not clearly defined nor are they given in any particular order; this has been done so that students may pursue the particular aspects that will contribute most to their own emerging pattern of understanding.

As an example, consider the stream activity *collecting bottom specimens of silt or pebbles.* A student might choose pebbles *or* silt. He might photograph the distribution of pebbles and calculate the average size. He might observe and record the areas that are covered with algae and estimate how much of the pebble protrudes above the stream bed. He might look for turbulence and zones of still water and discover the meaning of Reynold's number. Almost certainly he will notice the differing abundance levels of life around pebbles in the main current and in back eddies. He might observe and record the changes in a stream bed when he places a large rock in a current. These various experiments will make the student realize that a limnologist could spend a lifetime studying pebbles.

This guideline is intended as a foundation and framework for the development of courses at the local level. It guides but does not determine which topics should be selected, in what sequence activities should be pursued, or what approaches should be taken.

This guideline sets out a domain for studies. It suggests a general four-part scheme; it proposes many topics and even a range of alternative topics; it lists many activities as examples; it outlines broad aims towards which any course in environmental science should be directed; it proposes a viewpoint on evaluation based on these aims and the objectives related to them. This section outlines suggestions as to how courses may be designed.

The four aims of the course have been described in the previous section. Briefly they can be stated in the following terms:

- to enhance the development of the student in his many dimensions;
- to help the student find logical patterns in terms of which he can understand and describe his environment;
- to introduce the student to current techniques and methods of investigation;
- to help the student become sensitive to value issues so that he will be able to make wise decisions pertaining to the environment and the community.

These aims give this guideline its general direction; however, during both the planning of a course and the day-to-day activities that follow from it, teachers may set more specific objectives. These specific objectives will guide activities and form the basis of evaluation. As an example, some objectives that might be drawn up by a teacher are listed below. It will be noted that some of the objectives can be linked specifically to one or the other of the four aims summarized above. Others lead to these aims in a more general way. All represent various indications of sensitivity and accord with nature.

For example, one teacher may hope and expect the student:
- to be sensitive to the needs of others
- to work independently
- to assume responsibility
- to find pleasure in work
- to appreciate beauty
- to work with others
- to make decisions
- to trust others
- to see the universe as a related whole
- to understand some of the fundamental principles of science
- to represent the environment in pictorial form
- to describe aspects of the environment in words
- to recognize relationships among animals and plants
- to use technical words appropriately
- to explain an idea to another student
- to observe phenomena carefully
- to use instruments capably
- to record observations in many ways
- to express findings clearly
- to make and test hypotheses
- to draw logical conclusions
- to design good sampling procedures
- to interpolate data in a graph or in a table
- to adopt safe practices
- to search for references
- to identify environmental threats
- to protect living things
- to use resources according to the yield
- to improve an area of deteriorating environment
- to assess the conflict between the interests of man and other living things
- to enjoy the environment
- to join in community conservation activities.

Objectives such as those listed above will determine, to a large degree, viable approaches to planning, teaching, and evaluation of student growth and achievement.

In planning, it is necessary to achieve a balance between class studies that provide a common experience and individual ventures that provide a suitable challenge for each student.

Similarly, the teacher must aim for balance in the use of the open-air laboratory, the library, and the classroom. Topics can often be determined through compromise; students should be able to select areas that seem important and promising, while teachers should be able to present areas in which they have special knowledge or for which resources are available. Some topics may lend themselves at times to interdisciplinary studies; at other times, it may be necessary to study a single, specialized aspect of a discipline. Finally, there should be a balance between the student's self-directed activity and activities that are guided by the teacher.

Seeking Criteria of Achievement

This guideline proposes experiences that set the general direction for the study of the environment and suggests that courses should be developed locally to suit local conditions. The family of schools, consisting of a secondary school and its associated elementary schools, may initiate some of the curriculum development and choose topics, either those in this guideline or others suitable for a particular locality. At this level also, learning materials could be assessed and units planned. The most important planning, however, remains for teachers who are, through direct consultation with students, most capable of planning and guiding courses that are responsive to the aspirations and capabilities of their students. No matter what planning takes place at other levels, the ultimate responsibility lies with students and teachers.

In developing courses, many resources may be drawn upon. The principal of the school can assist and encourage on the basis of his view of the total program. Sometimes groups of teachers, each with special interests and expertise, may combine their efforts to sketch out a course; each may make a detailed study of one topic. Teachers may find help at conferences or in the published bulletins of such organizations as the Ontario Geography Teachers' Association, the Environmental Science Teachers' Association, and the Science Teachers' Association of Ontario. Finally, the community itself is a rich human resource. Teachers can expect expert advice from people whose work is tied to some particular segment of the environment: farmers, fruit growers, fishermen, planners, foresters, and builders all have experience that can increase the student's sensitivity to the relationships within the environment and make him more aware of his responsibility for the environment itself.

This section proposes criteria of achievement by which teachers and students may measure their progress against their own aims and objectives. Both need such processes of measurement. Each student requires assurance and recognition. Each teacher needs to know the success of his own teaching approach.

An evaluative reporting process is also necessary for those outside the classroom who require some information about the progress of the courses. The principal, for example, wants to ensure that the course in environmental science is serving the interests of both student and community. Parents must know both aims and achievements if they are to support the studies of their children. Further, the nearby community itself is interested. Many segments within the community are concerned about the environment and want to know whether this course responds to contemporary problems and develops a heightened awareness of the environment.

The primary purpose of the school is to enable each student to develop as an individual in society. Hence the education of each student should be evaluated in terms of his own progress, not in reference to competitive ranking schemes. Since changes are being evaluated from day to day or semester to semester, it becomes important to know the quality of daily work for each student.

The central thrust of the course – personal harmony with nature – is ideally the basis for all evaluation. In practical terms, this can be assessed as learning experiences, one by one, become part of the student's total thinking pattern.

For example, the following list of criteria all relate in one way or another to the original objectives. They are written in question form and the list is not complete. Such a list could also be of great benefit in encouraging self-evaluation by assisting the student to internalize his criteria and objectives so that he may gain some autonomy in his efforts to develop.

- To what extent has the student used reference sources?
- How clearly have the findings been expressed?
- How frequently have observations been expressed in numerical form?
- To what extent has the student worked with other students?
- With what facility have instruments been used?
- How much responsibility has been assumed?
- How well has the student criticized his own work?
- How carefully have conclusions been drawn?
- How often does he take initiative in a group?
- How wide are his interests?
- How sensitive is he to environmental threats?
- In what measure does he understand the great ideas of science?
- What is the richness of his concept of, say, *niche*?
- How well does he design experiments?
- In what degree does he find joy in his work?
- How accurately does he make calculations?
- To what degree does he follow safe laboratory practices?
- How appropriate is his use of technical words?
- With what skill does he express ideas through sketches?
- To what extent is the student considerate of living things?
- How fully does he see the universe as a related whole?
- How competently does he assess his own work?
- To what degree has he learned to solve problems?
- How well does he express ideas orally?
- To what degree can he interpolate with a line graph?
- How clearly does he express ideas in prose?
- To what extent does he give credit, where due, to others?
- How well is he able to work independently?

Evaluation has three aspects: the gathering of observations of the student's performance, the making of value judgements, and the sharing of both with all persons involved. Through continuing dialogue between student and teacher, between teacher and parents, and between the student and his parents, the best interests of the student will be served.

Part I

Man's Natural Environment and Its Components

The earth has been compared to a spacecraft. Everything necessary for life must be aboard: water, air, and much more. Man is surrounded by the life-supporting atmosphere and under his feet lies the earth's crust with its layer of soil and its mineral resources. Streaming through space, sunlight provides the energy that converts simpler compounds into organic materials; plants and animals are dependent on this input of energy for their activities.

These major components are, in fact, linked together, and it is suggested that early in this part of the course an ecosystem should be studied in totality. Each student can select and monitor a quadrat of land from day to day. Techniques need not be sophisticated, for the purpose of the study is to reveal the complexity of the environment. Nor should the influence of man escape examination, for even a small patch of land near the school is affected by him. After this preliminary study of a whole, the components could be studied analytically. Then, after the study of water, air, and the other components, a sophisticated examination of a pasture can provide a further look at an ecosystem in its entirety.

Work on the eight themes of Part I can lead to a better understanding of the environment. Through the suggested activities, students can gain the precise information and the practical experience on which theory is built. Practical studies, even of apparently simple phenomena, can lead to fundamental ideas that give meaning to the universe. Thus the stream that cuts into its banks exemplifies the principle that the face of the land is in continual change, and the presence of lichens and moss on shingle roofs is evidence that ecological succession is an orderly process. Student work that leads from the particular to the general is usually more challenging than the reverse, but it is essential that generalizations be made and concepts be enhanced.

Richness of understanding depends on thought and action; a student should have a chance to create with both mind and hand.

The environment nearby: a sampling
The careful study of a plot will lead not only to an understanding of the ecosystem but to a desire to know more about the many components of an ecosystem. For example, in a small quadrat laid out on a lawn at home or on part of the school grounds much can be learned about the small animals moving in the grasses. Most important of all, students can look for the relationships among living things and the relation of living things to environmental factors.

Suggested activities:
- tracing the history of ownership
- hunting for specialized books
- setting out an area for detailed study
- mapping the quadrat and surrounding area
- listening to the sounds reaching the quadrat
- listing the birds flying over the area
- noting the animals living on the surface
- capturing a sampling of animals in the soil
- examining the soil near the surface
- plotting the slope of the land
- naming the species of plants
- ascertaining the number of plants
- collecting seeds
- photographing the changes in dandelions day by day
- reading the temperature of the soil hour by hour
- measuring humidity or rates of evaporation
- observing the interface between sidewalk and lawn
- observing and listing the animals found in shady places
- taking decibel readings.

Note
1. At the end of most sections dealing with topics there is a list of activities or questions leading to activities. These indicate practical work that a student may undertake. What grows out of these activities is the important thing. In the course of each activity, students will refer to source materials, gather data, and eventually make a synthesis.

2. The select bibliography, to be found at the end of this guideline, lists specialized materials for most topics.

Water: the pervading compound
All life is intimately associated with water. No other chemical compound is so abundant on the surface of the earth; it fills the oceans, pervades the air, and forms a large part of the tissues of living things.

Photos: Pat and Ian Valentine

Students may approach the study of water through any of its many aspects. Some may assess its occurrence underground or at the surface. Some may be interested in the phenomena of snow, hail, and ice or water in clouds and glaciers. Some may prefer to study the value of water in transportation, recreation, and industry. Some may seek the aesthetic appeal of water as expressed in art and poetry.

This theme could be built on student questions, some of which may be like those listed below. The questions are starting points for rewarding activities that lead to the fundamental ideas associated with water.

- What is the monthly rainfall in the city nearest the school?
- Where is the nearest well?
- Where are the watersheds for Ontario rivers?
- At what temperature does water boil in the area?
- Does air dissolve in water?
- What are the arguments for and against fluoridation of water?
- Why is the ocean salty?

- What is the freezing point of ocean water?
- How can one drink river water safely?
- What is the difference between rain water and well water?
- How much water is there in bread?
- Why does soap cause a curd in hard water?
- What might be the range of community reaction to the flooding of land resulting from hydro-electric projects?
- How can we tell whether a stream is pure or polluted?
- If raisins swell in water, why do some woollen sweaters shrink?
- Does soil dissolve in water?
- Why does ice float?
- How does blotting paper work?
- How do the properties of water determine the organisms in it?
- How are the properties of water affected by living things within it?
- What are the arguments for and against the possible sale of water to the United States?
- Why do rivers not freeze at the bottom?
- Do fish find more oxygen in cold water or warm water?
- How much water do crops and trees require?
- What can one person do to correct water pollution?

Air: the surrounding medium

Through teacher-guided experiments, reading, student-selected ventures, and practical *hands-on* activities, a class can explore air in many parameters. Preliminary planning should include the identification of resources of all kinds.

The atmosphere can be looked upon as the ultimate place of interchange of gases for all living things. It can be regarded as the locale for weather or the medium for flight. It can be looked upon as a material with interesting scientific properties.

As students investigate air, they develop more and more adequate concepts of such phenomena as pressure, combustion, respiration, streamlines, drag-and-lift, and photosynthesis.

The following devices and phenomena could form the basis for studies: anemometers, barometers, breathing, candles, chimneys, dustfall, eddy currents around tall buildings, fans, kites, lime water, model aircraft, nitrogen-oxygen ratio, paper airplanes, pollution index, pumps, rusting of iron wool, sails, siphons, smog, smoke, visibility, wind, windbreaks, windmills, wind tunnels.

Soil: the base for land life

The thin layer of soil that covers the land masses supports the existence of every land organism directly or indirectly.

Soil differs greatly from place to place and decade to decade. It exists in constant change, being produced continually from inert materials and organic breakdown.

Students can collect soil samples. Macro- and micro-organisms can be observed, and the earthworms and arthropods in soil could be subjects for experiment. The soil itself can be sketched, photographed, and analysed as it is revealed in profile in a soil pit. Studies can include comparison of colour, smell, and texture and tests for pH and some chemical elements. Students may also assist in establishing a compost heap for the school greenhouse and flower beds.

The studies of soil could lead to an investigation of methods by which it has been cultivated throughout history. Some classes may find interest in local erosion control or in the local use of fertilizers. Some may want to read about the grants of land in the pioneering era and some may want to document the back-to-the-land movement of modern times. Some may want to examine the *Ontario Land Inventory* maps that show the relationship between soil types and the support of wildlife, forests, and recreational projects. Students might discuss the effect on soil of monocultural agriculture practices, sod farming, fall ploughing, or the persistent use of pesticides. Some students might investigate the way pesticides or the nitrates and phosphates used as fertilizers get from the soil into the aquatic systems.

Energy: the driving factor

Energy is essential to the existence of living beings. There are many cases where energy is transformed from one form to another. For example, a corn field will convert about one hundredth of the incident solar energy into stored chemical energy. Beef cattle will convert one tenth of the energy of the corn fodder into body tissue. Historically, great environmental and social changes accompanied the successive development of energy-producing devices such as windmills, water wheels, steam engines, gasoline engines, and nuclear reactors.

Through a wise choice of some of the following activities, a class could pursue a path in which *energy* is the link:

- determining the sources of energy within a home
- comparing the environmental and monetary costs of developing electrical energy from water power, coal, gas, and nuclear materials
- comparing the caloric values of different foods
- producing a solar spectrum
- finding out the length of the growing season in several Ontario areas
- observing and comparing the pollution resulting from vehicles producing energy from various materials
- reading about Rumford and the boring of cannon
- finding out the meaning of entropy
- making a model of a tidal-energy installation
- describing how geysers work
- finding the conditions necessary for photosynthesis
- measuring radiation with a radiometer
- tracing the energy changes in hydro-electric operations
- experimenting with the kinetic energy of wind and water currents
- observing energy transformations in a pendulum
- describing the energy changes in a coldframe

- finding out the meaning of *net ecosystem production*
- assessing the importance of the earth's internal energy from radioactive decay
- finding out methods by which the use of electrical energy can be reduced.

The plant life around man
This topic can give students information on plants as well as experience with plant life and an appreciation of plant relationships, both of which have begun to be lost with the shift toward urban living and the near-disappearance of the kitchen garden.

Students should have the opportunity to appreciate the beauty in plants and express their response in words or pictures. They should also be made aware of the scientific aspects and become familiar with such key ideas as succession, saprophytism, transpiration, and adaptation.

Suggested activities:
- sketching the plants in school flower beds
- cultivating plants
- describing a local greenhouse
- interviewing a gardener
- tracing the root systems of annuals
- discovering how roots obtain water
- mapping the trees near the school
- growing vegetables and flowers in flats
- watching twigs leaf out in spring
- examining sections through lumber
- experimenting with osmosis
- determining how factors like moisture and soil-mix affect the growth of plants
- verifying the production of starch by leaves
- investigating the mushroom industry
- reading about Linnaeus or the Saunders brothers
- examining plant tissues under a microscope
- graphing the monetary value of plant products in Ontario
- observing how a major forest disturbance causes a change in the species present
- comparing claims made in seed and nursery catalogues to results obtained in experience
- finding differences in micro-climate between a treed area and a meadow
- listing the animals found on specific plants
- writing a seasonal poem
- tracing the development of locally important products such as the sugarbeet, grape, potato, apple, tobacco, or tomato
- making a frequency distribution curve for various seeds falling through wind-tunnel air
- collecting the underground portion of a plant and comparing its dry weight with that of the portion above ground.

Animals in relation to man
Through this unit students can explore the role of animal life, both wild and domestic. Now that less than one-tenth of Ontario's population lives on farms, contact with livestock has diminished. Man is no less dependent on animals, however, and in many ways animals are even more dependent on man.

Suggested activities:
- making population counts of insects in the schoolyard
- examining the earthworm population in a lawn
- observing the behaviour of small mammals
- photographing squirrels
- describing a food chain
- incubating eggs
- listing foods eaten by a carnivore and a herbivore
- observing animals in a hay infusion
- finding the speed of travel of different animals
- making a census of mammals recently seen in the school community
- discovering the market value of farm animals
- reading about the endangered species in the province
- finding the sources of animal-origin food on store shelves
- researching the amounts of food eaten by farm animals
- discovering why deer have spread northwards
- photographing breeds of horses intended for different uses
- attending a livestock auction
- interviewing an exterminator
- investigating some of the parasites in the human body
- finding out the feeding techniques by which food-source domestic animals are matured early
- reading about the sustained-yield principle for wildlife
- finding the local capability for supporting wildlife by reference to an *Ontario Land Inventory* map
- determining the reproduction and mortality rates of various groups of animals
- investigating the concept of density-dependent mortality.

Pasture or clearings: a study of an open place
This unit would help the student obtain a comprehensive view of his environment. The field study could extend over several weeks and could cross many disciplines.

Sometimes regions for study can be found so close to the school that work can be done in the area during single class periods. Classes might look for open places such as (a) a natural clearing between forests, (b) an open town lot where the grass is not being cut, or (c) a pasture being used by cattle or horses.

A useful project would be to survey a lot destined for residential housing and determine the number of plant and animal species there. Then, with the necessary permission, students could survey a landscaped lot containing a house and compare the number of species and individual specimens.

Some of the activities could be the same as those listed in the section "The environment nearby: a sampling"; however, if this study is made *after* the study of the components of the environment, the techniques used can be more sophisticated.

No matter what kind of habitat is selected, the whole environment should be studied. In addition to components related to biology, chemistry, geology, and physics, there are components related to social and economic issues.

Other topics
Quite clearly, other components could have been selected – for example, *surveying* and *ownership of land, effects of cultivation, unusual weather,* or *abandonment of farms.*

In any year there may be special events affecting the environment. One could cite the *drainage of a field,* the *filling of a marsh,* the *opening of a gravel pit,* the *introduction of a new insecticide,* the *invention of a new winter travel vehicle,* the *building of a highway,* the *passing of a law concerning park areas,* the *building of a shopping complex,* the *development of a new sub-division,* or *changes in hunting and fishing.* In studying these events, there are two aspects to inquiry: documentation of events through careful observation and background research, and demonstration of the relation of the event to accumulated environmental knowledge.

Part II

Man Within the Natural Environment

Scattered across Ontario are areas that have not changed greatly in the past thousand years. They may be small patches or enormous tracts. For example, some forest areas have remained far from roads in summer and winter; some rock slopes have not tempted the farmer or the miner; some muskegs and marshes have been avoided by road-builders; some nearly natural areas have been preserved in their original condition because of the protective action taken by far-seeing individuals, organizations, or governments.

Man's power is reaching such proportions, however, that he threatens even this environment. This part of the Environmental Science course is intended especially to reinforce students' knowledge about the environment by developing sensitivity to its relationships and a feeling of responsibility for it.

The sections that follow can form the basis for units of work lasting a month or more. Students will be able to explore sample environments and find patterns of life and development.

There is a chance that students will look at the natural environment clinically without considering man's influence on nature and nature's influence on man. Accordingly, the chosen themes should be linked with the wide range of man's experiences.

The forests and forestry
Throughout history, the forest has provided man with shelter, fuel, and tools. The forest community of animals and plants has provided him with still further resources. Modern technology has increased the usefulness of trees to man and made their harvesting more efficient.

In Ontario it is relatively easy to find woodlots and forests that are natural, almost unmodified environments. The student may, by field observation and field trips, discover how trees interact with climate, water, soil, animals, insects, other plants, decomposing agents, fire, disease, and man. He can also discover that man is an important agent in forestry affairs and that it is his responsibility to ensure maximum benefits to forest and man with a minimum of harm to other resources and values.

Suggested activities:
- listening to the sounds of the forest
- measuring height, girth, and diameter of trees
- feeling and describing bark
- sampling a woods for species and for abundance
- discovering the rate of growth of trees
- devising botanical keys
- sketching tree shapes
- observing litter and duff
- measuring climate under tree cover
- estimating cordwood or lumber stands
- discovering seeds
- examining tree parts with a lens
- inferring the processes of growth
- searching for giant trees
- looking for animals on trees
- describing a rotting stump
- recording the characteristics of a woodlot in photographs or on tape
- obtaining the prices for lumber
- ascertaining the economic value of forestry products
- examining modern forestry equipment
- studying such painters of the Canadian forest as the Group of Seven and Emily Carr
- reading legends of Ti-Jean or Paul Bunyan
- singing songs of the lumbermen
- practising thinning of timber stands
- interviewing a forester
- making inferences about animal population from marks of browsing
- describing how one feels in a forest
- discovering why sumac grows in some places and not in others
- finding out the date of blooming for the trillium
- defining *sustained yield*
- depicting fire control equipment.

Life is running water
Small brooks and great rivers present challenging environments for study. In many ways, shallow streams are more useful than rivers for school study because the water-land interface is more accessible; a pebble lifted from a creekbed often reveals animals and plants. Similarly, the air-water interface can easily be observed from shore.

Suggested activities:
- discovering the source of a stream
- plotting the course on a map
- spreading a net to see what falls on the water surface
- finding the speed of the stream
- photographing the surface where there are eddies and rapids
- counting the invertebrates caught in dip-nets
- taking the water temperature
- surveying the changes in stream level
- collecting bottom specimens of silt or pebbles
- observing the anatomy of caddis structures
- determining the age of fish from scales
- photographing examples of pollutants
- making a census of fish species
- sketching fish
- describing methods of fishing
- reading about catches of earlier days
- observing how beavers control the water flow
- identifying aquatic plants
- measuring dissolved gases

- determining hardness of stream water
- studying the commercial exploitation of running water
- finding out legislation concerned with water quality
- finding effects of dams and drainage ditches on the ecological network.

The landscape and the resources beneath
A considerable fraction of Ontario is composed of rock outcrops, some in the form of rocky cliffs and rock summits. These have their own fauna and flora, just as a brook has its own animal and plant life.

In areas accessible to some schools, the rock environment is a source of ores. In others, the underfoot resources consist of gravel beds or of limestone or sandstone for quarrying.

The activities will depend greatly on the locality but they might include:

- sketching the rock outcrops
- collecting rock specimens
- making contour models from expanded plastic
- surveying slopes
- making a map of a geologic feature after a pace-and-compass survey
- comparing underground mining with quarrying
- collecting lichens
- making note of the animals crossing a rock surface
- looking for evidence of glaciation
- interviewing a prospector
- photographing markings on rocks
- collecting small pebbles and sorting them according to different criteria
- measuring the height of a hill
- finding how claims are staked
- reading prose and poetry dealing with the Gold Rush
- finding out the current mineral production in Ontario
- making a blow-pipe analysis of an ore
- making a census of plants near the top and along the base of a rise
- comparing numbers and species of plants and animals on a rock formation with those in an area of deep soil or in a sandy area
- observing the effect of mining operations on the environment
- comparing the living things on a north-facing ledge with those on a south-facing ledge
- comparing formations along a transect in the field with those shown on a map
- finding out the rate at which mineral resources are being used
- collecting photographs of the recycling of metals
- looking for crystals
- sketching and classifying fossils.

This topic may be used to clarify the difference between renewable and non-renewable resources.

Life in the lake environment
One-tenth of Ontario is covered by fresh water. There are thousands of lakes, ponds, and marshes accessible to many schools. The Great Lakes are unique in the world; with the opening of the new Canada Centre for Inland Waters at Burlington in 1971, a great impetus has been given to the study of limnology.

These inland waters may be studied through several aspects. Often there are beach phenomena; freeze-up and break-up are observable along the shores. Life under the ice can be probed in the middle of winter.

The following questions would lead to experiences in the domain of inland waters:
- What materials make up the lakeshore?
- What temperature is the lake at the surface and beneath the surface?
- What species of plants grow in shallow water?
- What is *Cladophora?*
- What kinds of fish are found near shore and what kinds in deep water?
- What historical information or legends about the lake under study are available?
- Where is the nearest commercial fishery?
- What food chains are found in the lake under study?
- How has the composition of the catch changed in commercial fishing over the years?
- What mammals thrive in the lake environment?
- How does sewage treatment lessen pollution?
- What species of fish are caught through the ice?
- What percentage of the gross national product is produced by the Canadian fishery industry?
- What species of fish are the most important commercially?
- What measures enhance human safety on lakes?
- What is meant by oxygen deficiency?
- What changes in lake level occur throughout the year?
- In what ways are the nearest lakes used for recreation?
- What is the date of the spring overturn on a nearby lake?
- What is the effect of water diversions on the Great Lakes?
- What is the significance of primary production?

Wildlife in the land environment
In this unit, students might examine the terrestrial parts of their natural surroundings and interpret what they see of the lives of animals. One goal is to see how the pieces fit together, for each animal has its niche and each affects others. Consequently, the student should see a wolf or an owl as an integral part of a natural community.

One can easily recognize five broad categories of land environment in Ontario. In the north is the boreal forest treed with pine, spruce, birch, and poplar, and sheltering the beaver and ruffed grouse. In many parts of Ontario, the environment consists of old fields that have not been farmed for three years or more, in which meadow voles and deer thrive. Two other kinds of environment are the mature deciduous forests with their grey squirrels and the mature coniferous forests with red squirrels. The fifth category is the marsh where redwings and waterfowl nest among the rushes and muskrats swim in the open water. Students will necessarily study the animals native to their own areas, finding in each satisfying experiences and often subjects for individual inquiry. Some students will acquire a perspective in which the cottontail as a species may be seen to share some of man's problems and abilities. Other students will be interested in how man attempts to support the survival of wildlife through management programs and through legislation. Some will be interested in the recreational outlets available to them as bird watchers, photographers, or amateur scientists. Some will see the economic importance of these living things, either directly or indirectly. Some may want to know more of the management of wildlife.

Suggested activities:
- counting the birds flying over a given area
- interviewing a trapper or a conservation officer
- finding out how snakes are classified and keyed
- writing a description of the behaviour of muskrats
- sketching patterns in spider webs
- reading animal stories by Farley Mowat
- keeping a sand trail to find what animals are moving across a land area
- finding the structure of an ant hill
- measuring the flight distance of sparrows
- making nesting boxes for bluebirds or black ducks
- recording the position of woodchuck burrows and the associated vegetation
- discovering snow tracks
- photographing the behaviour of squirrels and chipmunks and making comparisons
- matching student-recorded bird calls with commercial recordings
- finding out the limits of an animal's territory
- determining how an environment can be improved for a given species of wildlife
- sketching snails and slugs
- reading the current game regulations
- finding conflicts of interest between man and wildlife
- interpreting maps of the ranges of animals
- listing the species of wildlife in each of Ontario's five main environment categories
- discussing why non-hunted and non-trapped animals are no more common from year to year than game animals that are managed on a sustained-yield basis
- making a pitfall trap for soil insects
- finding how a deer population is maintained
- discussing the film *Death of a Legend*.

A comprehensive survey
Through earlier topics in Part II, students have been able to explore five distinct kinds of natural environment, but have not been given the opportunity to explore any one of them in depth.

Students should be able to find areas that differ with respect to landscape, aquatic features, or forms of life. They should have an opportunity to examine these areas comprehensively and to note ecological relationships and differences.

To cite a case, one class operated in work parties over hills, down slopes, across streams, and through woods, each party following a line transect along a compass bearing away from a dispersal centre. As the eight parties examined flora, fauna, relief, soil, and other features, they observed the gradual transition from one kind of environment to another. The parties pooled information to produce a map and papers on the area.

Other methods will suggest themselves. Students may, for example, set out a grid or follow country roads.

Other topics
Some environments worthy of study may be quite limited in size. A class could select a *short stretch of lakeshore* or a *single bend* in a stream. An abandoned farm or road would be a good area for investigating *how environments change.*

Exceptional weather can cause high lake levels, deeper snow cover, an increase in grass fires or forest fires, low stream flows, hail damage to grain, and glaze-storm injury to trees. The *atmosphere* is another part of the natural environment that affects man closely.

Some parts of Ontario have unique features of environment. For example, near Moosonee there is *marine life* and in the southwestern counties there is *Carolinian vegetation.* Within London there is a *spruce bog,* and *dunes* fringe some lakes. Students could find out how special features of the natural environment are conserved through the creation of parks.

Some aspects of the natural environment have critical contemporary importance: a study of an *endangered species* such as the red salamander, a *threatened land feature* such as a gravel-rich esker, or a *disappearing resource* such as the orchard land of Niagara. While the threads of preservation and conservation run throughout this course, they would be especially apparent in investigations of such topics.

Since the maintenance of the environment is a priority, students may want to probe and determine responsibilities for the *treatment of solid waste* or the *prevention of litter.*

Part III
Management of the Modified Environment

Thousands of years ago, man learned to make tools, to use fire, to keep some animals nearby in his control, and to plant and reap grains. As man has evolved from hunter to farmer and then to artisan, he has become more removed from direct contact with production, processing, and storage of food. Mechanization, specialization, and adaptation of environmental factors have released man to use his energy in modification of the environment.

Sometimes the modification is small. Fewer than 50,000 Ontarians live north of the Canadian National Railway and hence the character of the Hudson Bay lowlands is little changed. The modification is greater in a farmer's field in which one variety of one species is grown almost to the exclusion of other plants. In horticulture, cultivation is still more intense and conditions are still more controlled. Perhaps a peak of modification is shown in greenhouses, where soil may be sterilized, temperature controlled, air varied, watering scheduled, and light timed so that conditions are ideal.

A high degree of modification is also shown in the modern city and even more so in the towering modern office building. Some predictions forecast more extreme modifications in the future.

If a modified environment is to serve the needs of today and tomorrow, careful management is necessary. This management is based on the understanding of relationships within the environment. Through this part of the Environmental Science guideline, students can become aware of both man's power over the environment and the limits of that power.

Agriculture: production with environmental control
The industry of agriculture, although complex, has one common base, a dependence on the land. This unit contains suggestions for studying the diverse aspects of agriculture.

There are advantages in planning a balance in activities based on six aspects of agriculture: soil science, plant husbandry, animal husbandry, food science, agricultural engineering, and agricultural economics.

Through soil science, the student can appreciate the continual struggle of rebuilding, maintaining, and improving the soil. Through plant husbandry, he can see how genetic, nutritional, and physiological processes have led to increased crop yields. Through animal husbandry, he can learn more about the animals on which man depends for food, clothing, energy, and companionship.

A complex food industry has grown up around the processing of agricultural products. Many methods are used to prevent spoilage. Some of these may be tried by the students in the food science topic of this program.

Agricultural engineering has provided a measure of environmental control. Through drainage and irrigation, water can be managed. Through cultivation, the characteristics of soil are altered and the weeds are suppressed. Through diverse experiments, students can learn how the principles of physical and biological science apply to farm practice.

In agricultural economics, students investigate the economic factors that determine the size of farms, the choice of crops and livestock, and deployment of labour and machinery. Such a study could profitably be pursued in cooperation with teachers of economics.

Not all six aspects of agriculture need be studied by any one class; probably students and teachers will choose aspects that are relevant to the nearby community.

Suggested activities:
- searching out the history of local agriculture
- incubating eggs and raising chickens
- comparing efficiency of energy conversion of various farm animals
- raising and exhibiting a farm animal
- visiting a dairy, beef, or tobacco farm
- drawing farm buildings to scale or constructing scale models
- interviewing an agricultural representative
- preparing silage in the laboratory
- using a surveyor's level to plot profiles of terrain
- designing a drainage system
- reporting on the effectiveness of conveyors
- comparing samples of concrete made from different aggregates
- dissecting a fowl
- comparing ruminant and simple stomachs
- surveying and photographing farm management tools
- calculating the cost of producing and marketing a crop
- looking for new plant varieties and growing them
- preserving foods by heating, freezing, drying, or fermenting
- finding out about Canada's agricultural import and export trade
- maintaining a piece of farm machinery
- studying the pulleys and gears in use on farms
- surveying refrigeration and ventilation methods used on farms
- tracing the growth patterns of legume plants
- managing a small apiary
- observing rural hydro installations
- photographing wind-shelter belts
- taping an interview with a veterinarian
- assessing the danger of herbicides
- comparing gasoline and diesel engines for farm use
- determining the effect of the spread of agriculture on the animal population
- examining the difference between harvesting grain and clean-cutting a forest from an environmental point of view.

Coping with a northern environment
A unique environment is available for study in Ontario's northland. Students might investigate the causes and effects of such phenomena as extreme temperature range, heavy snowfall, kinds of muskeg, and Ontario's only seacoast. The extremes of climate offer scope for extensive study of human adaptation to environmental conditions. Many students will be interested in investigating the extent of the North's susceptibility to man's influence.

Northern students might begin their investigations by raising questions that could lead to studies. Here are some examples:

- How can one kind of muskeg be distinguished from another?
- Where is the nearest *wild river park?*
- Is there evidence that coastal lands are rising?
- Why are northerners building so many airports?
- What steps are being taken to avoid pollution from northern industries?
- What is the present Cree population in northern Ontario?
- Why are some places such as Fort Albany and Attawapiskat well populated, while the Sutton Ridges with their rock outcrops are not?
- What edible wild plants grow in the North?

- How close is your school to the permafrost line?
- How can roads be built on muskeg?
- What kinds of annual tree rings are found near the tree line?
- What kinds of vegetables can be grown in the open and what can be grown under plastic shelters?
- What is the history of sea travel at Fort Severn?
- When does break-up occur on northern lakes?
- What is the effect of long days on vegetation?
- What is the ground temperature in winter under snow?
- What is the hydro-electric energy potential of the river nearest to your school?
- What is the difference between *primitive parks* and *nature reserves?*
- What is the future of the North?
- What kinds of vegetation are found along the rail line to Moosonee?
- Can black flies be controlled?
- What do trappers say about the catches of earlier years?

It will be recognized that, as in the whole program, any of these questions can lead far beyond quick answers to a deep understanding of relationships between the living things in the environment, the land, and man himself.

Horticulture: the art and the science

Horticulture embraces both art and science. As a student arranges shrubs or flowers in pleasing patterns, he can develop his artistic talents and feel emotional satisfaction. When he grows trees and lawns of great beauty and harvests fruits and vegetables of quality, he has achieved competence through a scientific understanding of the plant and its environment and through horticultural skills.

Both urban and rural areas provide many opportunities for horticulture. In an urban area, students may explore plantings of trees, shrubs, and lawns and their contribution to beauty, privacy, quietness, and to the pleasures of gardening. In a fruit-growing area, the practices of planting, pruning, spraying, and harvesting may be studied. In a market-gardening area, the design of the land for efficient food production, the control of environment during storage, and the styles of marketing may prove interesting. In all cases the school program should reflect the community's horticultural environment.

Teachers and students may develop a course unit from some of the following activities:

- collecting and identifying plants
- establishing a nursery or vegetable plot on the school grounds
- growing and maintaining house plants on a window sill
- planting a fruit tree
- growing trees from seeds
- ordering flower seeds from a seed catalogue
- visiting a florist shop
- photographing an orchard
- designing a floral arrangement
- decorating the classroom seasonally
- tracing horticultural products in a supermarket back to the primary producer
- comparing prices of various horticultural products
- making sectional diagrams of fruits
- growing a perennial plant border
- setting up and operating a misting system for plant propagation
- producing a crop of flowers
- forcing flowering bulbs
- visiting a fruit storage building
- pruning a fruit tree
- dressing a tree wound
- determining the cost of producing a fruit crop
- comparing a lawn and a parking lot as ecosystems
- classifying plants using various criteria
- assuming responsibility for the lawns and landscaping on the school property
- building a protective structure for an old tree
- developing a spray calendar for apple trees
- devising experiments to compare sound and dust pollution levels in parks and street areas
- selecting and studying micro-climates
- building a small greenhouse
- designing a border for continuous bloom
- repairing and maintaining garden equipment
- growing and comparing five varieties of tomatoes
- raising vegetables through hydroponic techniques.

The school greenhouse: an environmental laboratory

A greenhouse permits a class to produce individual plants of fine quality in a highly controlled environment which calls for intensive care and hard work. Students have a chance to develop their "green thumb" skills and at the same time to see the applications of scientific principles.

The school greenhouse provides a proving ground for the principles of biology. Cultivation of plants may lead to investigations of such phenomena as tropisms and growth regulation. Some observations will lead back to basic principles of physics and chemistry. Through the experience of growing exotic plants in a shady, moist, warm environment, students can gain an appreciation of the conditions in a tropical forest and relate their practical work to geography.

While students are developing practical skills and investigating abstract ideas, they are also developing emotionally. They experience satisfaction as the seedlings change into sturdy plants, pride when flowers they have nurtured are shared with others.

Here are some subjects for study that could form the basis of broader investigation:

- greenhouse construction
- solar energy infiltration
- climate-controlling systems
- microclimates
- greenhouse design
- adaptations of plants to climatic factors
- photosynthesis
- examples of competition
- evidences of transpiration
- rate of growth under varied conditions
- effect of auxins and hormones
- action of selected herbicides and pesticides
- safe handling of chemicals
- choice of plant containers
- identification and safe use of tools
- soil composting
- soil sterilization techniques
- plant nutrition
- soil preparation
- seeding
- transplanting
- potting
- pruning
- flower production for pre-determined dates

- greenhouse ventilation
- peat moss
- growth chambers
- storage of tubers and corms
- record-keeping
- accounting.

Caution: As there are hazards associated with many pesticide chemicals, strict procedures in the operation of greenhouses are essential.

Where the greenhouse is attached to the school building, provision should be made to prevent any insecticide fog from permeating any part of the school. During disinfection by fog or gas, the greenhouse must be locked. Suitable protective clothing, along with a respirator, must always be available. The use of some pesticides is restricted to designated personnel. All pesticide chemicals must be stored in a locked cupboard and used only as the labels direct.

Aquaculture: a frontier of farming
Not all crops and animals in Ontario are produced on land. Commercial fisheries, although centered on Lake Erie, are scattered throughout the province. In addition, as the need for food grows with a growing population, the culture of aquatic plants and animals is likely to increase.

Here are activities that will give young people experience with the culture of aquatic life:

- setting up aquaria
- raising guppies or other fish
- examining wild rice
- growing rice on land
- reading about the harvesting of wild rice from Lake of the Woods
- growing lilies in a pond
- collecting clams and making chowder
- planting cat-tails and iris in a damp hollow
- making a film of a trout-hatchery operation
- surveying an excavated farm pond
- investigating how trout ponds are maintained
- observing the kinds of fish in warm-water fish ponds
- interviewing the owner of a farm pond
- visiting a hatchery for the culture of minnows for bait
- reading about the intensive indoor rearing of carp
- assessing predictions that the ocean will be the major source of nutrients for man in the future
- debating the implications of *gardens of the sea*
- assessing the popularity of dulse
- finding where algae are grown for food
- gathering recipes for cooking lake and ocean produce
- reading about the intensive vat cultivation of *Scenedesmus*
- setting up a marine aquarium
- reading about marine installations for the intensive culture of fish.

Other topics
Each of the topics described in the previous section suggests the study of an environment that has been modified by man. Some environments such as the greenhouse are much modified and some, such as the lakes producing wild rice, only a little.

The *domestication of animals,* so important to civilization, might be combined with *studies of single species* such as dogs, horses, goats, or sheep. The modified environments in a *modern zoo* could be linked with the life style of black bears, timber wolves, or other animals. Students could culture *marine animals* in the school by using salt-water aquaria.

The *agricultural ecosystems* can be compared to the natural ecosystems with respect to the net production of dry organic matter in grams per square metre per year.

The *modification of weather* has given rise to considerable scientific literature. Rain-making has been tried out over Canadian forests and it also has its myths, legends, and rites which would merit study. Also worthy of consideration are theories that industrial production is causing a *greenhouse effect* on a global scale.

In order to obtain an up-to-date view of a *total producing environment,* a class might undertake a survey of farm production in a township.

Public parks, ranging from wilderness areas to formal gardens, are examples of modified environments.

Students may also have the opportunity to study the way the environment has been modified through *urbanization.*

A family farm or a market garden could serve as a sample area for a survey in which a class could describe the *agricultural year.*

Part IV
Planning Man's Future in a Changing Environment

Why should students explore man's future in the changing environment? In the past, schools have been part of a world that was reasonably predictable; in science and other subjects, students dealt with data and theories that were founded on past experience. At present, however, school programs tend to reflect a general recognition of the need for research and planning, so that the environment of tomorrow may replace the environment of today in an orderly and constructive manner.

Another factor is the increasing importance of inquiry and discussion as part of the learning process. It is hoped that teachers will approach this section of the course with this in mind. The intention is not to provide a vehicle for personal prejudices or personal philosophies, but rather to raise value issues and to encourage a breadth and depth of study that will enable students to make logical and intelligent decisions.

In these future-oriented inquiries, the environment can be probed at the local or global level. Although it is the nearby community which influences students and upon which they can exert influence, it is the total world situation that will shape the future of humanity.

Conservation of natural resources
Public awareness has become sensitive to environmental concerns. Wise use of natural resources, however, requires understanding of fundamental principles as well as concern.

An essential principle in any conservation program is the distinction between renewable and non-renewable resources. For example, both plant life and wildlife can be regenerated in a matter of years, provided the plant and animal species have not become extinct. On the other hand, resources like mineral deposits and geological features are non-renewable. When nickel and natural gas are extracted to serve a population growing exponentially, reserves may be soon depleted, perhaps in less than two hundred years.

Through activities related to this topic, students can assess the world around them and begin to take responsibility for conservation of the natural heritage.

Suggested activities:
- calculating the soil run-off in a creek in spring
- photographing giant trees
- tabulating the mining of gravel over the years
- mapping the local occurrence of endangered plants
- sketching a marsh
- interviewing an amateur field naturalist
- exploring the idea of zero economic growth
- devising a simulation game based on conservation
- writing a short story to describe the feelings of the lone survivor of an animal species
- making a descriptive itinerary of a canoe route or old footpath
- photographing farmlands being turned into subdivisions
- visiting an incinerator or a garbage dump
- measuring the soil carried by drifting snow
- making a film on the wise use of water
- producing a booklet on local geological features
- measuring erosion along lakeshores
- interviewing a conservation officer
- participating in the recycling of paper.

Population trends
The changing flow of population has considerable influence on the extent of modification of the environment. Population figures also indicate many trends that affect people's lives; an example here would be the ratio of rural population to urban as shown in Canadian census figures over a considerable period of time.

In planning studies based on population trends, teachers of Environmental Science can add an extra dimension through consultation with their colleagues in the field of Urban Studies.

Planning, long-range and short-range
Students can assess their present environment in terms of living, working, and recreational conditions. They can also detect trends towards change: they can ascertain the aspirations of people in a neighbourhood and find out policies of local planners and provincial authorities which will affect the environment for centuries. Students can explore both official and regional plans; with this information and their own insights, they can share in the creation of a better environment.

Suggested activities:
- listing natural areas with special value as open space
- finding the area served by the neighbourhood schools
- photographing the buildings along a road
- listing ways of improving transportation to meet the needs of commuters
- making a catalogue of old houses or barns
- discussing the Haldimand-Norfolk appraisal study or reading the story of the growth of a planned community such as Manitouwadge
- examining maps of resort subdivisions to see how wisely river or lake frontage is used
- investigating how rural municipalities cope with problems of urbanization
- making a film illustrating the need for planning
- interviewing members of planning groups
- describing devices used to lessen traffic in residential areas
- investigating how citizens share in planning
- taping interviews showing how individuals feel about changes in their way of life
- studying the implications of a larger population with more leisure time and more disposable income.

The abatement of environmental stress
Changes in the environment often create additional stress for man. Sometimes he is able to lessen his problems by altering his style of life, a solution not always available to other living beings.

In cities, human behaviour can be adversely affected by crowding and by noise. Even beyond cities, air pollution has become a hazard to the individual and a limiting factor to industrial activity.

In the past decades, man has increased his use of water, so that severe shortages exist in some areas. The quality of water has also deteriorated, in part because of the kinds and amounts of liquid wastes allowed to enter rivers and lakes.

Solid waste has buried cities in the past, and at present its disposal still entails the waste of valuable land. Viewed positively, solid wastes constitute one of the few resources that can be used to supplement the diminishing supply of raw materials; recycling is becoming increasingly desirable.

In addition to these pervasive influences from the material environment, there are other stresses that good planning can alleviate. Some environments lack meeting places, libraries, and theatres. Others lack green zones, statuary, and fountains. Others suffer from uniformity of structure and design. Some skyscrapers rob other buildings of sunlight, and others cause canyons with winds reaching dangerous velocities.

Students can avoid negativism in pollution studies by probing toward action that seeks to abate environmental stress.

Suggested activities:
- measuring noise level
- examining garbage
- surveying the opinions of downtown citizens concerning the air they breathe
- measuring pollutants in creeks
- reading about the discovery and history of DDT
- comparing methods of treatment of solid wastes and garbage
- gauging the sense of community in a neighbourhood or apartment complex
- tabulating the phosphate content of detergents
- discovering how tobacco smoke can be reduced
- comparing urban and rural dwellers with respect to health or longevity
- searching for methods of packaging that involve little solid waste
- finding the average distance between students' homes and the nearest library or cinema
- measuring the hours of sunlight at a downtown location
- comparing wind velocities in an open place and near highrise buildings
- comparing rural and city temperatures
- determining the effect of flash floods on sewage systems
- assessing ways of securing exhaust-free transportation
- evaluating the costs of improvement.

Caution: Sometimes streams, ponds, and ditches are contaminated with coliform and other organisms that may cause infection or disease if the contaminated water enters the body. The study of pollution of water should, therefore, be conducted with special care.

Preservation of the cultural heritage
As a starting point for a study of their cultural heritage, students could investigate the history and significance of older buildings in their own communities. The study could expand into the area of possible restoration or preservation, probably through co-operation with teachers of History and Art.

Students can examine the growing demand for city environments with style and tradition. They can also investigate the cycle of older buildings that are adapted for new uses once they cease to serve their original purpose. An example here would be the conversion of an old firehall into a theatre or restaurant.

Suggested activities:
- photographing buildings in a block
- making models of public buildings
- looking up old town maps
- finding out the role of the Ontario Heritage Foundation and the Architectural Conservancy of Ontario
- producing an annotated catalogue of pictures or paintings of the home town
- sketching one side of a street
- examining the brickwork around windows
- assisting experts in an archaeological dig
- visiting a restored village
- interviewing an architect
- collecting reminiscences from older citizens
- collecting old schoolbooks
- alerting others to old landmarks
- making a booklet describing the architecture of the school
- photographing commemorative statues and plaques
- tracing the ownership of a dwelling.

Food today and tomorrow
At present about half of humanity is hungry or malnourished. By the end of the century, the world's population will double, and if each person is to have enough to eat, the world's food supplies will have to be trebled. Throughout this topic, possible solutions can be investigated and reinforced with contributions from teachers of such subjects as Family Studies, Geography, and Physical and Health Education.

The topic also opens up a study of the Canadian diet and probable changes in world food consumption. Since more meals will be eaten away from home, individual packaging is likely to increase. Since some popular foods such as potato chips have little nutritional value, they will likely be fortified, as white bread has been. Since protein is scarce in many parts of the world, it is likely that meat substitutes will be increasingly used.

Clearly the activities in this topic will be related to the kinds of foods produced, processed, packaged, and consumed locally. They will also vary with the interests of the student and the experiences of the teacher.

Suggested activities:
- making production graphs of wheat or cheese
- making tables of the import of foodstuffs
- finding out the calorie intake in various regions of the world
- comparing the cost of raising chickens and rabbits for food
- making jams or jellies from local fruits
- comparing the energy input required to produce protein in cattle, chickens, and fish
- collecting maple sap and preparing syrup for sale
- examining intermediate-moisture soups and dog foods
- reading about meat analogues such as fabricated wieners
- evaluating results of the *Green Revolution*
- examining the labelling on foods
- recognizing the edible native plants
- forecasting man's future foods
- assessing the litter hazards in food packing
- preserving foods by salting or drying
- recording the stages in food processing after visiting a bakery or a cannery
- studying the *Food and Drug* laws of Canada
- assessing the value of *organic foods*
- studying the quality of nutrition in various regions of the world.

Beauty through landscaping and architectural design

As urbanization continues, more and more citizens will find themselves surrounded by glass and concrete. The everyday opportunities for strolling amid trees or for treading on grass will become fewer.

Through intelligent landscaping, however, man can satisfy his needs for living space and beauty. Landscaping creates moods in the natural environment through imaginative and aesthetic blending of engineering and horticultural skills. In parallel fashion, architectural design can create moods in the structural environment through sensitive use of materials, form, and style.

In this topic, as in others in Part IV, students have the dual task of finding out about their environment and finding out how to reach decisions about it. In teaching, this requires a mixture of scientific procedures and humane deliberations about value issues, always with a view to possible solutions and with regard for the values of others.

Students who choose this topic will have many opportunities for practical work. While films, simulations, and books provide support, the real world of park, street, and countryside provides first-order experiences and introduces local issues.

Students may work in groups along the lines suggested in the activities listed below, eventually making group presentations and inviting discussion. Different activities focus on different aspects of a single problem and lead to a discussion of possible decisions.

Suggested activities:
- making a film contrasting a pleasant street-corner with an unpleasant one
- finding out what children like for a playground
- analysing a landscaped garden
- selecting and planting a small shade tree
- designing a patio area or an ornamental lily-pool
- assessing a park in relation to the needs of citizens
- maintaining a pensioner's lawn as a personal responsibility
- describing the appeal of a local public building
- finding out how a park is kept clean by assisting the person responsible
- looking in a catalogue for shade plants or for hardy shrubs
- devising a campaign to prevent littering
- pruning roses
- photographing trees around historic buildings
- researching landscaping styles reflecting different periods
- constructing models to show a worked-out gravel pit or quarry and the same hollow restored through landscaping
- analysing the types of plantings along a major highway
- building a sidewalk or a retaining wall
- making a set of slides showing a landscape at monthly intervals
- photographing buildings that enhance the appeal of their surroundings
- preparing sketches to show how a row of century-old buildings might be restored to its original condition
- suggesting landscaping ideas for improving the home environment
- photographing sculpture in association with buildings
- interviewing an architect
- making alternative landscape designs for a school site
- discussing problems of decision-making at various levels – personal, governmental, and corporate.

Other topics

This section, bridging the present and future, can be treated with all the precision that contemporary data allow or with all the speculation that the future's uncertainty permits.

Many topics may be added to the ones that follow. Some classes may be interested in the increased food resources that *hybridizing of plants and animals makes possible.* Others may want to know more of *the techniques of selective breeding and adaptation.* Still others may want to make forecasts of the *environment of the future* or to write science fiction based on planetary environment. Another possible topic is the *economics of the environment,* in which students may trace the monetary losses that result from pollution or the expenses incurred by industry in combatting it. Others may want to probe the link between the *environment and the human condition.*

Select Bibliography

The following entries provide information on books and brochures that might be of assistance to teachers as they develop curriculum for Environmental Science. These references are listed under the guideline topics for which they are most relevant. In general, the entries represent materials suitable for teacher use and are not chosen as student references. A few non-print items have been listed at the end of each topic to complete the nucleus of source material.

Part I
Man's Environment and Its Components

The environment nearby: a sampling

Aguesse, Pierre. *Clefs pour l'écologie.* Paris: Edition Seghers, 1971.

Ce livre porte sur les éléments de la biosphère et démontre la relation entre l'homme et l'univers.

Miles, Phyllis M., and Miles, H. B. *Town Ecology.* London: Hulton Educational Publications, 1967. (In Canada, Bellhaven House, Scarborough, Ontario.)

Although the keys are designed for British fauna and flora, the book suggests field methods suitable for ecological studies in Canadian towns.

🍁 OISE Media Group. *The Guide to the Ecology Box.* Toronto: Ontario Institute for Studies in Education, 1971.

Intended for use with the Ecology Box produced by the same group, this large illustrated booklet provides ideas and suggestions for inquiries.

🍁 Université du Québec. *Québec Science* (mensuel). Université du Québec, 2875 boulevard Laurier, Ste-Foy, Québec 10.

Ce magazine est publié par l'Université du Québec en collaboration avec le ministère de l'Education et l'Association canadienne française pour l'avancement des sciences. Les articles très variés traitent du milieu canadien.

Water: the pervading compound

Dussart, Bernard. *Limnologie, l'étude des eaux continentales.* Paris: Gauthier-Villars, 1966.

Cet ouvrage spécialisé discute les propriétés physiques et chimiques de l'eau, la nature des lacs et des rivières. Il traite également des animaux et des plantes variés qui y vivent.

🍁 Cram, J. S. *Water: Canadian Needs and Resources.* Montreal: Harvest House, 1969.

This book deals with the use of water in Canada, the control of water quality, and Canada-United States relations in respect to water.

Kazmann, Raphael G. *Modern Hydrology.* 2d ed. New York: Harper & Row, 1972. (In Canada, Fitzhenry & Whiteside, Don Mills, Ontario.)

This book treats precipitation, evaporation, surface water, ground water, and water resource development.

Air: the surrounding medium

Dobson, G. M. B. *Exploring the Atmosphere.* Oxford: Clarendon Press, 1968.

A review of the whole atmosphere is followed by a discussion of the formation of cloud, rain, hail, and thunderstorms. Further chapters treat the ionosphere and the magnetosphere.

Landeau, Richard, ed. *Air Conservation.* Washington: American Association for the Advancement of Science, 1965.

This publication of the Air Conservation Commission contains background reports on meteorology, pollutants, socio-economic factors, and measures for air pollution control.

Soil: the base for land life

Clarke, G. R. *The Study of the Soil in the Field.* 5th ed. Oxford: Clarendon Press, 1971. (In Canada, Oxford University Press, Don Mills, Ontario.)

Although semi-technical, the book describes soil-profile pits and procedures for soil-sampling that science teachers can adapt for Ontario schools.

🍁 Hoffman, D. W.; Matthews, B. C.; and Wicklund, R. E. *Soil Survey of Dufferin County.* Report No. 38 of Ontario Soil Survey Research Branch, Canada Department of Agriculture and Ontario Agricultural College, Guelph, 1964.

This report contains maps and a description of the landscape, types of soil, and the development of agriculture as a part of community life. Similar reports are available for many other counties.

Pesson, P., ed. *La vie dans les sols.* Paris: Gauthier-Villars, 1971.

Présentée à Paris en 1969, cette série de documents spécialisés décrit la faune du sol et d'autres sujets connexes.

🍁 Scott, Auguste. *Les sols.* Montréal: Librairie Beauchemin Limitée, 1968.

Ce livre illustré traite des sols en relation avec les plantes. Il s'occupe également de l'origine, l'évolution et la classification des sols divers dans quelques terrains canadiens.

🍁 Webber, L. R., and Hoffman, D. W. *Origin Classification and Use of Ontario Soils.* Toronto: Ontario Ministry of Agriculture and Food, 1967.

The book links soils with geology through maps and describes soil structure with the aid of colour illustrations.

Energy: the driving factor

Brown, Theodore, L. *Energy and the Environment.* Columbus, Ohio: Charles Merrill, 1971. (In Canada, Charles E. Merrill Publishing, Downsview, Ontario.)

The book describes how man's generation and consumption of energy can affect the quality and character of his natural surroundings in the present and for the future.

Dajoz, Roger. *Précis d'écologie.* Paris: Dunod, 1971.

Ce livre détaillé examine le domaine entier de l'écologie et comprend des sections concernant les transferts de matière et d'énergie dans les écosystèmes.

Kormondy, Edward J. *Concepts of Ecology.* Englewood Cliffs, N.J.: Prentice-Hall, 1969. (In Canada, Prentice-Hall of Canada, Scarborough, Ontario.)

The first chapters deal with ecosystems and the associated energy flow and biogeochemical cycles. The last ones treat populations and communities.

Maillet, Pierre. *L'énergie.* Paris: Presses Universitaires de France, 1966. (Au Canada, Les Editions Champlain Ltée, Toronto.)

Cette brochure traite de la production, l'emploi, le coût, et les sources de l'énergie pour l'avenir.

Phillipson, John. *Ecological Energetics.* London: Edward Arnold Publishers, 1966. (In Canada, MacMillan Company of Canada, Toronto.)

The booklet deals with the energy transformations that occur within ecosystems.

The plant life around man

Curtis, J. T., and Cottam, Grant. *Plant Ecology Workbook*. Minneapolis, Minn.: Burgess Publishing, 1962. (In Canada, McAinsh & Co., Toronto.)

This laboratory, field, and reference manual suggests many techniques and provides models for outdoor work.

Handler, Philip, ed. *Biology and the Future of Man.* New York: Oxford University Press, 1970. Paper edition, 1971. (In Canada, Oxford University Press, Don Mills, Ontario.)

The first half contains a summary of the current understanding in the life sciences. The latter half contains chapters on the future of man, environmental health, industrial technology, resources, medical practice, and the feeding of mankind.

Oosting, Henry J. *The Study of Plant Communities.* 2d ed. San Francisco: W. H. Freeman & Co., 1956.

This book surveys plant ecology and includes aspects of energy and soil.

Animals in relationship to man

Chauchard, Paul. *Sociétés animales, société humaine.* Paris: Presses Universitaires de France, 1963. (Au Canada, Les Editions Champlain Ltée, Toronto.)

C'est une étude comparative du développement social chez certains animaux et chez l'homme.

Zeuner, Frederick E. *A History of Domesticated Animals.* New York: Harper & Row, 1964. (In Canada, Fitzhenry & Whiteside, Don Mills, Ontario.)

This well illustrated, scholarly book fuses together archeological and biological information in order to describe how domestication developed from the natural contacts of man with beast, which in the early stages were provided mainly by hunting.

🍁 *Life in the Woodlot* (colour) 16 mins. National Film Board, 1 Lombard Street, Toronto, Ontario M5C 1J6.

This film brings into focus a pyramid of life where some orders of fauna support others and where a parallel struggle for supremacy occurs in the plant world.

Pasture or clearings: a study of an open place

Collier, Boyd D.; Cox, G.; Johnson, A.; and Miller, P. *Dynamic Ecology.* Englewood Cliffs, N.J.: Prentice-Hall, 1973. (In Canada, Prentice-Hall of Canada, Scarborough, Ontario.)

This background book cites the principles underlying any study of the environment.

Lewis, T., and Taylor, L. R. *Introduction to Experimental Ecology.* London: Academic Press, 1967.

This book, based on 45 exercises suitable for town and country, provides an introduction to a wide range of ecological concepts.

Sankey, John. *A Guide to Field Biology.* Harlow, England: Longman Group, 1958. (In Canada, Longman Canada, Don Mills, Ontario.)

This handy pocket-size book describes many techniques of field work suitable for teenage students.

Part II
Man Within the Natural Environment

The forests and forestry

🍁 Canada, Forest Products Research Branch. *Canadian Woods: Their Properties and Uses.* Ottawa: Queen's Printer, 1951.

This book is intended to promote and facilitate the effective utilization of wood.

Ovington, J. D. *Woodlands.* London: English Universities Press, 1965. (In Canada, Musson Book Company, Don Mills, Ontario.)

This book describes the structure of a forest, the woodland community, the relation between trees and soil, and management of forests.

Stoddard, Charles H. *Essentials of Forestry Practice.* New York: Ronald Press, 1968. (In Canada, Renouf Publishing Co., Montreal, Quebec, and Smithers and Bonellie Ltd., Toronto, Ontario.)

This book discusses field practices and operations in the growing, logging, protecting, harvesting, and processing of timber.

Life in running water

🍁 Hynes, H. B. N. *The Ecology of Running Waters.* Toronto: University of Toronto Press, 1970.

This scholarly book brings together almost the whole of the world literature on stream limnology for a teacher's reference.

Vivier, Paul. *La vie dans les eaux douces.* Paris: Presses Universitaires de France, 1972. (Au Canada, Les Editions Champlain Ltée, Toronto.)

On a basé cette initiation à la limnologie sur les concepts de communauté et d'écosystème.

The landscape and the resources beneath

🍁 Coleman, A. P. *Lake Iroquois and Geology of North Shore of Lake Ontario.* Forty-fifth Annual Report of Ontario Department of Mines, 1936. Toronto: Ontario Ministry of Natural Resources, 1937.

Dr. Coleman in a classic report describes the landscape around Lake Ontario, which provides evidence of a glacial lake that existed some 16,000 years ago.

Furon, Raymond. *Formulaire du géologie.* Paris: Lechevalier, 1962.

C'est une introduction à l'étude des problèmes pratiques qui se présentent pour le jeune praticien qui veut excursionner, observer, récolter des échantillons, les préparer, les identifier, et les conserver.

🍁 Pye, E. G. *Geology and Scenery: North Shore of Lake Superior.* Toronto: Ontario Department of Mines, 1969.

This book lists points of geological interest near the principal highways of the region north of Lake Superior.

Life in the lake environment

Mills, D. H. *An Introduction to Freshwater Ecology.* Edinburgh: Oliver and Boyd, 1972. (In Canada, Clarke, Irwin & Company, Toronto.)

This illustrated booklet discusses the characteristics of water, water bodies, plant and animal communities, energy flow, and other topics. Exercises are designed to support field studies and projects.

Needham, J. G., and Needham, P. R. *A Guide to the Study of Freshwater Biology.* San Francisco: Holden-Day, 1962.

This booklet describes many simple methods for field study of streams and lakes, provides many keys, and contains hundreds of sketches to assist in the identification of aquatic plants and animals.

Wildlife in the land environment

Newman, Hugh. *Les animaux, leur comportement.* Paris: Editions RST, 1965.

Ce livre traite des habitudes et du comportement des animaux, reliant ceux-ci aux aspects physiologiques et sociaux.

Wallwork, John A. *Ecology of Soil Animals.* New York: McGraw-Hill Book Company, 1971. (In Canada, McGraw-Hill Ryerson, Scarborough, Ontario.)

While most of the book treats soil animals, some chapters describe soil itself.

Watt, Kenneth E. F. *Ecology and Resource Management.* New York: McGraw-Hill Book Company, 1968. (In Canada, McGraw-Hill Ryerson, Scarborough, Ontario.)

This book, rich in tables and graphs, provides examples to illustrate the principles of ecology and the impact of man on populations. The section on resource management requires a mathematical background of calculus and statistics, although here also sample cases are discussed.

A comprehensive survey

Benton, Allen H., and Werner, William E. *Manual for Field Biology and Ecology.* 5th ed. Minneapolis, Minn.: Burgess Publishing Co., 1972. (In Canada, McAinsh & Co., Toronto.)

This detailed guide to a variety of field studies contains techniques for sampling and for collecting and organizing data.

Odum, Eugene P. *Ecology.* New York: Holt, Rinehart and Winston, 1963. (In Canada, Holt, Rinehart and Winston of Canada, Toronto.)

This book is organized around pictorial or graphic models to illustrate the fundamental principles of ecology.

Part III
Management of the Modified Environment

Agriculture: production with environmental control

Campbell, John R., and Lasley, John F. *The Science of Animals That Serve Mankind.* New York: McGraw-Hill Book Company, 1969. (In Canada, McGraw-Hill Ryerson, Scarborough, Ontario.)

This reference text concentrates on the scientific aspects of domesticated animals under such headings as animal products, genetics, anatomy, physiology of growth, environmental physiology, and animal behaviour.

🍁 Ontario, Ministry of Agriculture and Food. *Agricultural Films and Slide Sets 1973-74.* Film Library, Information Branch, Ontario Ministry of Agriculture and Food, Guelph, Ontario N1G 2W1.

This publication lists nearly 500 films and over 100 slide sets and is revised every few years. These films and slide sets, covering a wide range of farm and community topics, may be borrowed without charge from the Film Library.

🍁 Ontario, Ministry of the Environment. *Environmental Aspects of Development.* Toronto: Ontario Ministry of the Environment, 1971.

This dossier for teachers provides information on urban problems such as land use and noise, and also discusses the concepts and principles underlying agriculture.

🍁 University of Guelph. *Notes on Agriculture.* Co-ordinator of Agricultural Extension, Ontario Agricultural College, University of Guelph, Guelph, Ontario N1G 2W1.

This magazine, written by experts, devotes each issue to one major theme. Recent issues have been concerned with the following: *Chemicals in Animal Agriculture, Environmental Quality,* and *Rural Development Involving People, Resources, and Communities in a Changing Society.* It is published three times a year.

🍁 Walker, Dean. *Canada's Agriculture.* Toronto: McGraw-Hill Ryerson, 1970.

Treating agriculture as an art, a science, and an industry, the book traces the country's agricultural development from the early farming pioneers to today's technological era.

Coping with a northern environment

🍁 MacFarlane, Ivan C., ed. *Muskeg Engineering Handbook.* Toronto: University of Toronto Press, 1969.

Detailed coverage is given to the recognition and classication of muskeg areas, as well as to the problems muskeg presents in the building of roads, airstrips, and other structures.

🍁 Spencer, Loraine, and Holland, Susan. *Northern Ontario: A Bibliography.* Toronto: University of Toronto Press, 1968.

Limited to the area lying north of the Canadian National Railways through Cochrane and Sioux Lookout, this bibliography lists books, periodicals, articles and government reports.

🍁 *The Northern Corps* (colour) 13 mins. Produced by the Ontario Ministry of Education, available from Library Media Services, Ministry of Education, Mowat Block, Toronto, Ontario M7A 1L3.

This film provides a brief look into the life of a man-and-wife teacher team who work with the Ojibwa in a northern community on Lake Nipigon.

Horticulture: the art and the science

🍁 Hamilton, G. H.; Crawford, H. R.; Hook, R. A.; Wilkes, L. J.; and Savage, B. W. *Horticulture for Profit and Pleasure.* Toronto: J. M. Dent & Sons (Canada), 1969.

Covering the entire range of horticulture, the book suggests experiments that students can undertake.

🍁 *The Chemicals of Plenty* (colour) 25 mins. Produced by the Ontario Ministry of Agriculture and Food, available from Film Library, Information Branch, Ontario Ministry of Agriculture and Food, Guelph, Ontario N1G 2W1.

This film points out the advances made in the use of pesticides to maintain production and the quality of field and horticultural crops, and probes the effectiveness and the hazards of their use.

The greenhouse: an environmental laboratory

Lewis, C. C. *The Greenhouse.* London: Pergamon Press, 1965. (In Canada, Pergamon of Canada, Toronto.)

This book, written to support secondary school courses, describes school greenhouses and their heating, suitable plant materials, and equipment. It includes 39 assignments.

Nelson, K. S. *Flower and Plant Production in the Greenhouse.* Danville, Ill.: Interstate Publishers, 1967.

Written on a practical level, this survey covers the floriculture industry, the growing structure, and the factors important to flower crops.

🍁 *The Inside Story* (colour) 22 mins. Produced by the Ontario Ministry of Agriculture and Food, available from the Film Library, Information Branch, Ontario Ministry of Agriculture and Food, Guelph, Ontario N1G 2W1.

This film describes how greenhouses are used in growing such plants as cucumbers and tomatoes and how these are prepared for marketing.

Aquaculture: a frontier of farming

Aubert, Maurice. *Cultiver l'océan.* Paris: Presses Universitaires de France, 1965. (Au Canada, Les Editions Champlain Ltée, Toronto.)

La première partie de cette brochure décrit le milieu marin, la deuxième, l'influence de l'homme sur les êtres marins, et la troisième partie démontre comment on fait l'élevage marin.

🍁 Dore, William G. *Wild-rice.* Ottawa: Department of Agriculture, 1969.

This well illustrated booklet describes the botany, distribution, habitat requirements, and utilization of the only cereal crop that grows wild in Canada.

Huet, Marcel. *Traité de pisciculture.* Bruxelles: De Wyngaert, 1960.

Ce livre décrit la construction et l'entretien des étangs pour la culture du poisson, en particulier l'élevage de la carpe et du saumon.

Royce, William F. *Introduction to the Fishery Sciences.* New York: Academic Press, 1972. (In Canada, Renouf Publishing Co., Montreal, Quebec.)

This advanced book describes the environment, ecology, and life style of aquatic animals commonly included in fisheries, and also discusses the management of fisheries and aquaculture.

Part IV
Planning Man's Future in a Changing Environment

Conservation of natural resources

Meadows, Donella H.; Meadows, Dennis L.; Randers, Jorgen; and Behrens, William. *The Limits to Growth.* New York: Universe Books, 1972. (In Canada, Burns & MacEachern, Don Mills, Ontario.)

Growing from a meeting of the Club of Rome, this well illustrated paperback predicts an overshoot and collapse of population and industrial growth within the next century, barring wise action.

McKenzie, Garry D., and Utgard, Russell O. *Man and his Physical Environment.* Minneapolis, Minn.: Burgess Publishing Co., 1972. (In Canada, McAinsh & Co., Toronto.)

These readings in environmental geology stress the preservation of the natural heritage.

National Academy of Science, Committee on Resources and Man. *Resources and Man.* San Francisco: W. H. Freeman & Co., 1969.

This report evaluates American and world resources in the light of current and expected stresses, considers the time scale, and recommends steps to deal with some of the important problems.

Planning, long-range and short-range

🍁 Blumenfeld, Hans. *The Modern Metropolis: Its Origins, Growth Characteristics and Planning.* Montreal: Harvest House, 1967.

The essays in this book can serve as a solid base for exploration in the planning field.

Derycke, Pierre-Henri. *L'économie urbaine.* Paris: Presses Universitaires de France, 1970. (Au Canada, Les Editions Champlain Ltée, Toronto.)

Cet ouvrage présente l'ensemble des données économiques du fait urbain. Il décrit les méthodes de l'analyse urbaine et de la maîtrise de la croissance urbaine.

🍁 Gertler, L. O., ed. *Planning the Canadian Environment.* Montreal: Harvest House, 1968.

These selections from the journal of the Town Planning Institute of Canada show Canadian contributions to town and regional planning from 1959 to 1965.

Kahn, Herman, and Weiner, Anthony J. *The Year 2000.* New York: Macmillan Co., 1967. (In Canada, Macmillan Co., of Canada, Toronto.)

This book, with its many tables and figures, provides a framework for speculation on the near future.

🍁 *A City is Born* (colour) 28 mins. Produced by the Government of Ontario, available from Conservation Education Section, Ontario Ministry of Natural Resources, Queen's Park, Toronto, Ontario M7A 1W4.

This film describes the planning and development of the whole town of Elliot Lake after the discovery of uranium.

Abatement of environmental stress

Association pour le Développement du Droit Mondial. *La Défense de l'homme contre les pollutions.* Paris: Editions Pedone, 1970.

Ce compte rendu démontre comment l'homme est protégé contre la pollution au point de vue légal.

🍁 Chant, Donald A., ed. *Pollution Probe.* Toronto: New Press, 1972.

This handbook describes many kinds of pollution and suggests measures that individuals and groups can take to improve their environment.

🍁 Chaput, Marcel, et Le Sauteur, Tony. *Dossier Pollution.* Montréal: Editions du Jour, 1971.

C'est un traité relevant les problèmes de la pollution sous toutes ses formes tant dans les centres urbains que ruraux.

🍁 De Vos, Anthony, ed. *The Pollution Reader.* Montreal: Harvest House, 1968.

The twenty essays that issued from a conference sponsored by the Canadian Council of Resource Ministers cover many aspects of environmental pollution.

🍁 Pollution Probe. *Environmental Education.* Pollution Probe, University of Toronto, Toronto, Ontario M5S 1A1.

This newsletter allows teachers to keep in touch with the current projects of Pollution Probe and to receive information and ideas that may be of assistance in planning units focused on environmental problems. It is published every two months. Pollution Probe also produces other resource materials.

🍁 Sylvestre, Roger, ed. *Critère.* Montréal: Collège Ahuntsic, 1972.

Cette série de comptes rendus traite de l'environnement sous la rubrique de: les problèmes éducatifs du milieu, les principes d'écologie, et la civilisation et le milieu.

Garbage (colour) 10 mins. Produced by King Screen Productions, available from Marlin Motion Pictures Ltd., 47 Lakeshore Road East, Port Credit, Ontario.

This visual essay is intended to alert the viewer to the growing garbage problem.

Preservation of the cultural heritage

🍁 Central Mortgage and Housing Corporation. *Habitat.* Ottawa, Central Mortgage and Housing Corporation. Bimonthly.

This beautifully illustrated publication contains many articles concerning city planning, new and old buildings, and architecture. Some articles are written in English and some in French. It is published six times a year.

🍁 Deffontaines, Pierre. *L'homme et l'hiver au Canada.* Québec: Presses de l'Université Laval, 1957.

Ce livre démontre comment les édifices canadiens étaient adaptés à l'hiver canadien et il examine d'autres conséquences de l'hiver sur l'homme.

🍁 *Time Piece* (colour) 15 mins. National Film Board, 1 Lombard Street, Toronto, Ontario M5C 1J6.

This is a film about the scholarship, discipline, and skills used in reconstructing and restoring sites of historical importance to Canada.

Food today and tomorrow

Lowenberg, Miriam E.; Todhunter, E. Neige; Wilson, Eva D.; Feeney, Moira C.; and Savage, Jane R. *Food and Man.* New York: John Wiley & Sons, 1968. (In Canada, John Wiley & Sons Canada, Rexdale, Ontario.)

The second half of the book describes the effects of hunger and malnutrition and presents the nutritional challenge of the future.

Food Preservation. 116 slides. Produced by Purdue University, available from the Film Library, Information Branch, Ontario Ministry of Agriculture and Food, Guelph, Ontario N1G 2W1.

These slides provide a practical guide to freezing, canning, and other preserving methods for common fruits and vegetables.

🍁 *The Global Struggle for Food* (b/w) 28 mins. National Film Board, 1 Lombard Street, Toronto, Ontario M5C 1J6.

The film shows how water control, land redistribution, and agricultural advances stem the tides of hunger.

Beauty through landscaping and architectural design

🍁 Bauer, Anthony M. *Guide to Site Development and Rehabilitation of Pits and Quarries.* Toronto: Ontario Ministry of Natural Resources, 1970.

This report suggests methods of site planning and site improvement during mining, and provides examples of mined-out land that has been developed for residential, industrial, and commercial use.

Center of Ekistics. *Ekistics.* Center of Ekistics, Box 471, Athens 136, Greece.

This monthly periodical contains reviews on the problems of science and human settlements.

Landscaping for the Future (colour) 15 mins. Produced by Cornell University, available from the Film Library, Information Branch, Ontario Ministry of Agriculture and Food, Guelph, Ontario N1G 2W1.

This film describes methods of landscaping home grounds with flowering shrubs, evergreens, and other trees.

🍁 *Vivre sa ville* (en couleurs) 17 mins. Une production de l'Office National du Film, on peut se procurer le film à l'Office National du Film, 1 rue Lombard, Toronto, Ontario M5C 1J6.

Paysage humain par excellence, la ville est en proie à un développement désordonné, à la décrépitude et à la pollution sonore, visuelle et atmosphérique. La rénovation urbaine tente de faire échec à ces maux.

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